INSTRUCTION MANUAL

FOR

REGULATED POWER SUPPLIES

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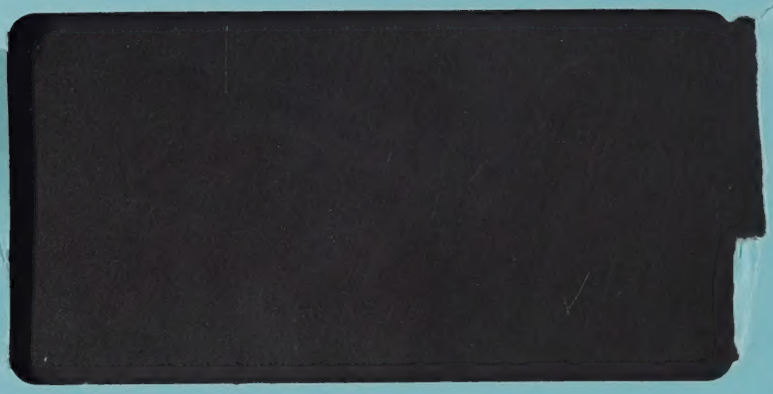
BOEING

MODEL LE 101-M-1795-1

MP MASTER
MA28323

BOEING

LAMBDA ELECTRONICS CORP. MELVILLE, NEW YORK



BOEING

MODEL LE 101-M-1795-1

ADDENDA

MODEL LE 101-M-1795-1

The paragraphs of this instruction manual apply in general to the above model.

This modified unit differs from a standard unit in the following ways:

1. A specially painted and chromated front panel has replaced the standard Lambda front panel.
2. Shimmed slides have been mounted on both sides of the power supply.

PRELIMINARY

INSTRUCTION MANUAL

FOR

REGULATED POWER SUPPLIES

MODEL LE 101

MODEL LE 101-M

MODEL LE 101-FM

This manual provides instructions intended for the operation of Lambda power supplies, and is not to be reproduced without the written consent of Lambda Electronics Corp. All information contained herein applies to both metered and non-metered models unless otherwise specified.

LAMBDA ELECTRONICS CORP. MELVILLE, L. I., N. Y.

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SPECIFICATIONS AND FEATURES

Specifications apply for the non-metered LE 101 and metered LE 101-M and LE 101-FM* models.

*For FM suffixed models specifications relate to rear output terminals only.

DC OUTPUT--Voltage regulated for line and load

Voltage Range	0-36 volts DC
Current Range	0-5 amperes, for entire voltage range

REGULATED VOLTAGE OUTPUT

Regulation (line)	Less than 0.05 percent or 8 millivolts, whichever is greater, for input variations from 105-135 or 135-105 volts AC
Regulation (load)	Less than 0.05 percent or 8 millivolts, whichever is greater, for load variations from 0 to full load or full load to 0
Transient Response (line)	Output voltage is constant within regulation specifications for any 15-volt line voltage change within 105-135 volts AC
Transient Response (load)	Output voltage is constant within 25 millivolts for load changes from 0 to full load or full load to 0, within 50 microseconds after application
Remote Programming Constant	50 ohms/volt output, constant over entire regulated voltage range
Internal Impedance	Less than 4.0 milliohms
Ripple and Noise	Less than 0.5 millivolts rms with either positive or negative terminal grounded
Temperature Coefficient	Output change in voltage less than 0.015%/°C

DC OUTPUT--Current regulated for line and load

Current Range	0.5-5 amperes
Voltage Range	0-36 volts DC, for entire current range

REGULATED CURRENT OUTPUT

Regulation (line).....Less than 0.2 percent or 15 milliamperes, whichever is greater, for input variations from 105-135 or 135-105 volts AC

Regulation (load).....Less than 0.2 percent or 15 milliamperes, whichever is greater, for load voltage changes from 0 to 36 or 36 to 0 volts DC

Ripple and Noise.....Less than 10 milliamperes rms with either positive or negative terminal grounded

Remote Programming.....500 ohm 4 watt resistor adjustable over entire regulated current range

AC INPUT--105-135 volts AC at either 45-66 cps* or 320-480 cps*; 350 watts**

* Use the frequency selector switch to use power supply at either input power frequency band

** With output loaded to full rating and input voltage 135 volts AC

OVERLOAD PROTECTION

Thermal.....Thermostat, reset by power switch; thermal overload indicator, front panel

Electrical

External.....Adjustable, automatic, electronic current-limiting circuit, settable from 10 percent to 110 percent of load; limits output current to preset limit for protection of load and power supply when external overloads and direct shorts occur

Internal.....Fuses provide protection against internal circuit failure

INPUT AND OUTPUT CONNECTIONS--Heavy duty terminal block on rear of chassis with 8-foot, 3-wire detachable line cord for all models; three, five-way binding posts provide for additional positive (+) ground and negative (-) DC output connections on front panel of FM models

OPERATING AMBIENT TEMPERATURE AND DUTY CYCLE--Continuous duty at full load from 0°C to +50°C (122°F) ambient

STORAGE TEMPERATURE - -55°C to +85°C (non-operating)

METERS--Ruggedized voltmeter and ammeter on metered models

CONTROLS

DC Output Controls.....	Coarse and fine voltage controls and current control adjust and limit DC output; located on front panel of FM models and on rear of all models
Remote Sensing.....	Provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation
Operating Mode Monitor.....	Load fault indicator illuminates when load conditions cause departure from selected mode of operation

PHYSICAL DATA

Mounting.....	Standard 19" rack mounting
Size.....	3 1/2"H x 19"W x 16"D
Weight.....	55 lbs. net; 85 lbs. shipping wt.
Panel Finish.....	Grey ripple enamel (standard); special finishes available to customer's specifications at moderate surcharge.

OPERATING INSTRUCTIONS

CONTROLS, INSTRUMENTS AND FUSES

POWER ON Switch. The POWER ON switch, located on the front panel, controls application of input power to the supply and resets the thermostat after thermal overload occurs. When the switch is in the ON position, the green POWER ON indicator glows. When THERMAL OVERLOAD indicator lights, place POWER ON switch in off (down) position to reset thermostat.

VOLTAGE CONTROLS V AND ΔV. Voltage Control V, a coarse adjustment potentiometer, varies the DC voltage over a range of 0-35 volts and control ΔV, the fine adjustment potentiometer, varies the DC voltage over a one-volt range. Clockwise rotation results in increasing voltage. The total DC voltage output, for voltage regulated operation, is equal to the sum of V and ΔV setting; for current regulated operation the maximum voltage limit is equal to the sum of V and ΔV setting. Both controls are located on the rear deck of all units as well as on the front panel of all FM suffixed units. On the FM units, use only the front panel controls.

CURRENT CONTROL-CURRENT LIMITER Control. This potentiometer varies the DC current over a range of 0.5-5.5 amperes and, for current or voltage regulated operation, limits the DC current output to the setting on the control. Clockwise rotation results in increasing current. This control is located on the rear deck of all models as well as on the front panel of FM suffixed models. On FM models only use the front panel current control.

INPUT FREQ SWITCH. The INPUT FREQ SWITCH, with toggle locking plate, located on the rear deck of all models, permits selection of power supply operation from either of two input frequency bands; 45-66 cps or 320-480 cps. Loosen two screws to release the toggle locking plate and place toggle to desired frequency band position, tighten the screws to secure the toggle in position.

INDICATOR SELECTOR Switch and LOAD FAULT ON Indicator. The INDICATOR SELECTOR switch permits the selection of either CURRENT REGULATED or VOLTAGE REGULATED mode of operation to be monitored by the LOAD FAULT ON indicator. When monitoring either mode of operation, the LOAD FAULT ON indicator will illuminate to indicate that load conditions have exceeded the preset limits for the selected mode of operation and the unit no longer is functioning in the selected operating mode. Both indicator and switch are front-panel mounted on all models.

Thermostat and THERMAL OVERLOAD Indicator. The thermostat, located inside the rear deck, opens when the temperature of the supply exceeds a maximum safe value. Opening of the thermostat causes the red THERMAL OVERLOAD indicator on the front panel to glow. Place POWER ON switch in off (down) position to reset thermostat and to allow the supply to cool. When proper temperature is reached, place POWER ON switch to the ON position to restore normal operation.

OUTPUT VOLTAGE Meter. A 0-36 volts DC voltmeter monitors the voltage at the output terminals of metered units.

OUTPUT CURRENT Meter. A 0-5 ampere DC ammeter monitors the load output current of metered units.

Fuses. Fuse F1, located on the rear deck, is a 1 1/4-ampere 3AG "SLO-BLO" fuse which functions in the internal DC auxiliary circuits. Fuse F2, located on the rear deck, is a 15-ampere 3AG "SLO-BLO" fuse which functions in the AC input circuit.

Connection terminals. Make all connections to the supply at the terminal block on the rear deck. On FM suffixed models DC output connections can also be made via three five-way binding posts located on the front panel. Apply input power through the line cord or directly to terminals 1 and 2 if the line cord is removed. Always connect the ungrounded (hot) power lead to terminal 1.

The supply positive terminal is brought out to terminal 4. The supply negative terminal is brought out to terminal 6. Recommended wiring of the power supply to the load and selection of wiring is shown in figures 1 through 11. Selection of proper wiring is made on the basis of load requirements. Make all performance checks and measurements of current or voltage at the rear output terminals. Connect measuring devices directly to terminals or use the shortest leads possible.

GROUND CONNECTIONS

The Lambda power supply can be operated either with negative or positive output terminal grounded or with no terminal grounded. Both positive and negative ground connections are shown in the diagrams for all suggested output connections illustrated in this manual.

NOTE: When operating the supply with neither terminal grounded, high impedance leakage resistance and capacitance paths can exist between the power supply circuitry and chassis ground.

BASIC MODES OF OPERATION

This power supply is designed to operate as a constant voltage source or as a constant current source. Automatic crossover to either mode of operation occurs when load conditions change as follows:

Constant Voltage. The power supply will function as a constant voltage source while the load current does not equal the current value, I_{LIM}, set by the CURRENT CONTROL-CURRENT LIMITER control. When load current $I_L = \frac{V + \Delta V}{R_L} = I_{LIM}$ the supply will cross over automatically and will operate as a constant current source. Further decrease in value of R_L results in decrease of voltage across the load while current remains limited at I_{LIM}.

Constant Current. The power supply will function as a constant current source while the load voltage V_L does not equal the voltage value set by VOLTAGE CONTROLS V and ΔV. When load voltage $V_L = V + \Delta V$, the supply will automatically cross over and operate as a constant voltage source.

SUPPLY LOAD CONNECTIONS

SAFETY NOTICE

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. OBSERVE THE USUAL SAFETY PRECAUTIONS WHEN OPERATING OR SERVICING THE EQUIPMENT TO AVOID SHOCK OR INJURY.

Connections for Operation as a Constant Voltage Source

The output impedance, regulation and transient response of the power supply at the load may change when using the supply as a constant voltage source and connecting leads of practical length are used. To minimize the effect of the output leads on these characteristics, remote sensing is used. Recommended types of supply load connections with local or remote sensing are described in the following paragraphs.

Refer to figures 1 and 2 to determine voltage drop for particular cable length, wire size and current conditions. Lead lengths must be measured from supply terminals to load terminals as shown in figure 3.

Two-Wire Connection, Figure 4. The two-wire connection, with local sensing, is the connection suitable for application with relatively constant load where extremely close load regulation and fast transient response over full-rated current excursion are not required at the load.

Improved Two-Wire Connection, Figure 5. The improved two-wire connection, with local sensing, is suitable for applications where excessively long connecting leads are not used. Using multiple paralleled leads in this type of connection reduces the supply-load lead voltage drop and permits improved regulation and transient response.

Four-Wire Connection, Figure 6. The four-wire connection with remote sensing, provides complete compensation for the DC voltage drops in the connecting cables. Compensation for lead drop is also valid for gradual changes of load current.

Programmed Voltage Connections, Figures 7 and 8. Discrete voltage steps can be programmed with a resistance voltage divider valued at 50 ohms/volt output and a shorting-type switch as shown in figure 7. When continuous voltage variations are required, use a variable resistor with the same 50 ohms/volt ratio in place of the resistive voltage divider and shorting type switch. Use a low temperature coefficient resistor to assure most stable operation.

As shown in figures 7 and 8, voltage can be programmed utilizing either local or remote sensing connections, as desired. In addition, figures 10 and 11 illustrate how the Lambda power supply can be connected to provide programmed voltage with local or remote sensing, together with programmed current.

Connections for Operation as a Constant Current Source

Figure 4 shows the connections which are used when operating the power supply as a constant current source with local setting of current control.

Programmed Current Connections, Figure 9. To provide discrete current steps from 10% to 110% of rated current, use any combination of separate 4-watt resistors totaling 500 ohms together with a shorting-type switch connected as shown in figure 9. Use resistors with low temperature coefficients to assure most stable operation.

When continuous current variations are required, use a 500 ohm 4-watt variable resistor in place of the separate resistors and shorting-type switch.

As shown in figures 10 and 11, Lambda power supplies can be connected to provide programmed current together with programmed voltage.

OPERATING PROCEDURES

CAUTION

For all FM model power supplies, when performing steps of operating procedure that require adjusting the VOLTAGE CONTROLS V and △V knobs the CURRENT CONTROL-CURRENT LIMITER knob, only adjust the front-panel mounted voltage and current controls. Rear-deck mounted controls for all FM models must remain locked in the full CCW position and must never be disturbed.

SAFETY NOTICE

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Constant Voltage Operation, Adjustable Current Limit

1. Remove AC power input to the supply and place POWER ON switch in down position before connecting load to the supply.

2. Determine load requirements, select wire size from figures 1-3 and choose correct type of supply-load connection from figures 4-6.

3. Connect supply to load as shown on the selected connection diagram.

NOTE: When shipped from the factory, the supply is ready for use as a constant current source or as a local-sensing constant voltage source. Jumpers are connected at the factory as shown in figure 4. Take care to remove the appropriate jumpers for load requirements that need different supply-load connections. Refer to the appropriate connection diagram.

4. Turn VOLTAGE CONTROLS V and △V knobs to the desired voltage setting. See CAUTION on page 7.

5. When current to the load must be limited to an intermediate value within the current limit rating of the supply, turn the CURRENT CONTROL-CURRENT LIMITER control to the desired current limit setting. If no intermediate current limit is required, turn the control to the full CW position to obtain current limit at maximum current limit rating of the supply. See CAUTION on page 7.

6. Apply AC power to the supply. Place INPUT FREQ SWITCH in appropriate position and lock in position.

7. Place INDICATOR SELECTOR switch in VOLTAGE REGULATED position.

8. Place POWER ON switch in up position and check that green POWER ON indicator is lit, and that red LOAD FAULT ON indicator is not lit.

9. Check that OUTPUT CURRENT and OUTPUT VOLTAGE meters indicate desired values; as required, adjust VOLTAGE CONTROLS V and △V and CURRENT LIMITER control to obtain correct meter indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6.

10. Check that red THERMAL OVERLOAD indicator is not lit. Power supply is now in proper operation.

Programmed Constant Voltage Operation, Adjustable Current Limit

1. Remove AC power input to the supply and place POWER ON switch in down position before connecting load to the supply.

2. Determine load requirements, select wire size and length from figures 1, 2 and 3 and choose correct type of supply-load connection from figures 7 and 8 or 10 and 11. Refer to paragraph on Programmed Voltage Connections.

3. Connect supply to load as shown on the selected connection diagram. Take care to use a shorting-type switch for the external programming control when several voltages are desired.

4. Turn VOLTAGE CONTROLS V and △V knobs to the extreme CCW position. Adjust external programmed voltage control to desired voltage setting. See CAUTION on page 7.

5. When current to the load must be limited to an intermediate value within the current limit rating of the supply, turn the CURRENT CONTROL-CURRENT LIMITER knob to the desired current limit setting. If no intermediate current limit is desired, turn the control to the full CW position to obtain current limit at the maximum current limit rating of the supply. See CAUTION on page 7.

6. Apply AC power to the supply. Place INPUT FREQ SWITCH in appropriate position and lock in position.

7. Place INDICATOR SELECTOR switch in VOLTAGE REGULATED position.

8. Place POWER ON switch in up position and check that green POWER ON indicator is lit and that red LOAD FAULT ON indicator is not lit.

9. Check that OUTPUT CURRENT and OUTPUT VOLTAGE meters indicate desired values; as required, adjust CURRENT LIMITER knob and external programmed voltage control to obtain correct meter indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6.

10. Check that red THERMAL OVERLOAD indicator is not lit. Power supply is now operating properly.

Constant Current Operation, Adjustable Voltage Limit

1. Remove AC power input to the supply and place POWER ON switch in down position before connecting load to the supply.

2. Determine load requirements and connect load to the supply as shown in figure 4.

3. Turn the CURRENT CONTROL-CURRENT LIMITER knob to the desired current setting. See CAUTION on page 7.

4. When load voltage must be limited to an intermediate value within the voltage rating of the supply, turn VOLTAGE CONTROLS V and ΔV to the desired voltage limit setting. If no intermediate voltage limit, within rating of supply is desired, turn V and ΔV controls to the full CW position to obtain voltage limit at maximum voltage rating of the supply. See CAUTION on page 7.

5. Apply AC power to the supply. Place INPUT FREQ SWITCH in appropriate position and lock in position.

6. Place INDICATOR SELECTOR switch in CURRENT REGULATED position.

7. Place POWER ON switch in up position and check that green POWER ON indicator is lit and that red LOAD FAULT ON indicator is not lit.

8. Check that OUTPUT CURRENT and OUTPUT VOLTAGE meters indicate desired values; adjust V and ΔV voltage controls and CURRENT LIMITER control as required to obtain correct indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6.

9. Check that red THERMAL OVERLOAD indicator is not lit. Power supply is now in proper operation.

Programmed Constant Current Operation, Adjustable Voltage Limit

1. Remove AC power input to the supply and place POWER ON switch in off (down) position before connecting load to the supply.

2. Determine load requirements and choose correct type of supply-load connection from figures 9, 10 and 11. Refer to paragraph on Programmed Current Connections.

3. Connect supply to load as shown on the selected connection diagram.

4. Turn the CURRENT CONTROL-CURRENT LIMITER knob to the extreme CCW position. Adjust external programmed current control to desired current setting. See CAUTION on page 7.

5. When load voltage must be limited to an intermediate value within the voltage rating of the supply, turn VOLTAGE CONTROLS V and ΔV to the desired limit setting. If no intermediate voltage limit, within the rating of the supply, is desired turn the V and ΔV controls to the full CW position to obtain voltage limit at maximum voltage rating of the supply. See CAUTION on page 7.

6. Apply AC power to the supply. Place INPUT FREQ SWITCH in appropriate position and lock in position.

7. Place INDICATOR SELECTOR switch in CURRENT REGULATED position.

8. Place POWER ON switch in ON (up) position and check that green POWER ON indicator is lit and that red LOAD FAULT ON indicator is <u>not</u> lit.

9. Check that OUTPUT CURRENT and OUTPUT VOLTAGE meters indicate desired values; as required, adjust external programmed current control and V and ΔV voltage controls to obtain correct indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6.

10. Check that red THERMAL OVERLOAD indicator is not lit. Power supply is now in proper operation.

OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

Thermostat Shutdown

The thermostat opens the input circuit only when the temperature of the rear deck exceeds a maximum safe value. Place the POWER ON switch in the off (down) position to reset the thermostat. After eliminating the cause(s) for overheating and allowing time for the power supply to cool to a proper temperature, resume operation of the supply. Refer to appropriate paragraph in OPERATING PROCEDURES.

Fuse Shutdown

Internal component failure is prevented by fuses which protect the components from damage caused by excessive currents. Fuses will blow when the maximum rated current value for the fuse is exceeded. Fatigue failure of fuses can occur when mechanical vibrations from the installation combine with thermally induced stresses to weaken the fuse metal. Many fuse failures are caused by a temporary condition, and replacing the blown fuse will make the fuse protected circuit operative.

SERIES OPERATION

For series operation, a maximum of 200 volts can be connected between either the +DC or -DC terminal and chassis ground. When operating two (2) or more power supplies, of equal or unequal rating, in series, clamping diodes of suitable rating must be used across each of the power supplies to prevent reverse voltage from appearing across any of the individual supplies. This reverse voltage can appear under certain operating conditions and cause damage to the electrolytic output capacitors. Contact the nearest office of the Lambda Electronics Corp. for recommended diode rating suitable for specific series operation.

ADJUSTMENT OF CALIBRATION CONTROLS

Adjust Calibration Control R4 as Follows:

1. Operate the power supply for constant voltage, with local-sensing jumpers connected as shown in figure 4, and no external load.

2. Turn VOLTAGE CONTROLS V (R2) to 35-volt position and ΔV (R1) to 1-volt position.

3. Adjust R4 for 36 volts DC output, using a DC voltmeter of one percent accuracy or better. Turn the shaft firmly to break the glyptal thread-seal.

4. Apply several drops of glyptal to the threads of the potentiometer shaft to lock the shaft in position after adjustment is completed.

Adjust Calibration Control R16 as follows:

1. Operate the power supply for constant current, with short circuit across output terminals.

2. Turn CURRENT CONTROL-CURRENT LIMITER control (R14) CW to the 5.0 ampere position.

3. Adjust R16 for 5.0 amperes DC output, using any DC ammeter of one percent accuracy or better. Turn the shaft firmly to break the glyptal thread-seal.

4. Apply several drops of glyptal to the threads of the potentiometer shaft to lock the shaft in position after adjustment is completed.

Adjust Calibration R49 as Follows:

1. Operate the power supply under the following conditions:

   a. Input: 135 volts at 60 cps.
   b. Mode: Constant voltage at full load, with local sensing. (see figure 4.)
   c. Output: 36 volts DC at 5 amperes.
   d. Temperature: 25°C ambient, approximately. Use a fan to apply forced air cooling to the coarse regulator (Q13 component board)

2. Using a DC VTVM, John Fluke Model 801H or equivalent, connect VTVM across collector and emitter of transistor Q19.

3. Adjust calibration control R49 until voltmeter indicates 6.9 volts. Turn the shaft firmly to break the glyptal thread-seal.

4. Apply several drops of glyptal to the threads of the potentiometer shaft to lock the shaft in position, after adjustment is completed.

PERFORMANCE CHECKS

Checks With Constant Voltage Operation

Check the ripple or regulation of the power supply using the test connection diagram shown in figure 12. Use suggested test equipment or equivalent to obtain accurate results. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Set the differential meter, DC VTVM (John Fluke Model 801H or equivalent) to the selected power supply operating voltage. Check the power supply load regulation accuracy while switching from the load to the no-load condition. Long load leads should be a twisted pair to minimize AC pick-up.

Use a Variac to vary the line voltage from 105-135 or 135-105 volts AC and check the power supply line regulation accuracy on the VTVM differential meter.

Use a VTVM, Ballantine 320 or equivalent, to measure rms ripple voltage of the power supply DC output.

Checks With Constant Current Operation

Check the ripple or regulation of the power supply using the test connection diagram shown in figure 13. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Check the power supply load regulation accuracy while switching from the short circuit to load condition. Measure the voltage across sensing resistor Rs. Use John Fluke Model 801H or equivalent for the VTVM connected across Rs. For Rs, use a 0.19-ohm, 16-watt resistor. To obtain regulation figure, substitute values obtained into regulation formula:

$$\frac{\Delta E}{Rs} = \text{Regulation in milliamperes,}$$

where ΔE is the voltage change in millivolts and Rs is the resistance of the sensing resistor.

Use a Variac to vary the line voltage from 105-135 or 135-105 volts AC and check the power supply line regulation accuracy using VTVM and the regulation formula $\frac{\Delta E}{Rs}$.

To measure rms ripple current of the power supply DC output, use a Ballantine Model 320 or equivalent meter and obtain ripple current I_r by substituting measured values into formula:

$$\frac{\text{V A.C. rms}}{Rs} = I_r$$

SERVICE

When additional instructions are required or repair service is desired, contact the nearest office of the Lambda Electronics Corp. where trained personnel and complete facilities are ready to assist you.

Please include the power supply model and serial number together with complete details of the problem. On receipt of this information, Lambda will supply service data or advise shipping for factory repair service.

All repairs not covered by the warranty will be billed at cost and an estimate forwarded for approval before work is started.

PARTS ORDERING

Standard components and special components used in the Lambda power supply can be obtained from the factory. In case of emergency, critical spare parts are available through any Lambda office.

The following information must be included when ordering parts:

1. Model number and serial number of power supply and purchase date.

2. Lambda part number.

3. Description of part together with circuit designation.

4. If part is not an electronic part, or is not listed, provide a description, function, and location of the part.

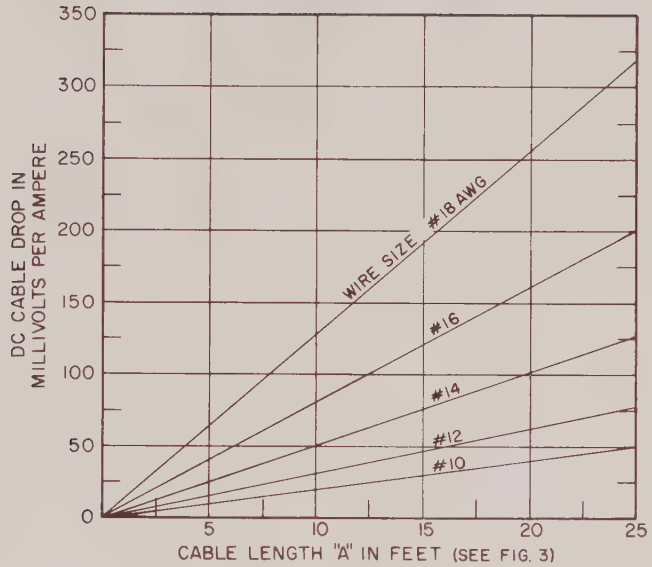


FIG.1. 2-WIRE CONNECTION (SEE FIG. 4)

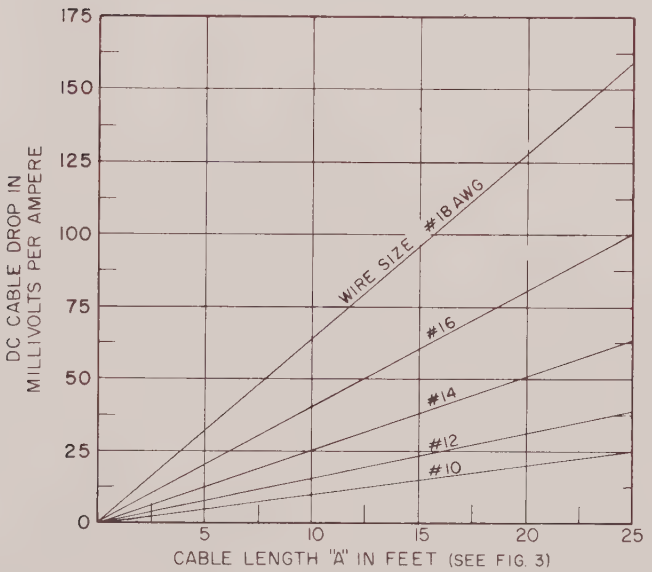


FIG. 2. IMPROVED 2-WIRE CONNECTION (SEE FIG.5)

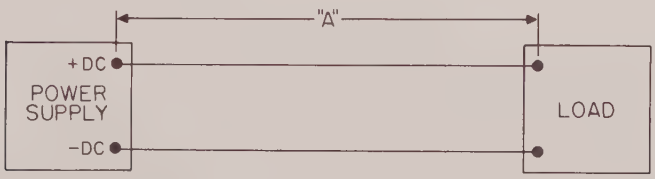
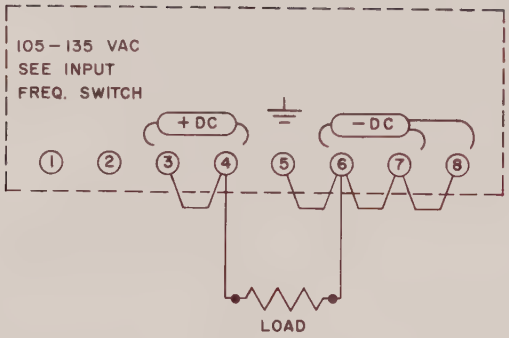
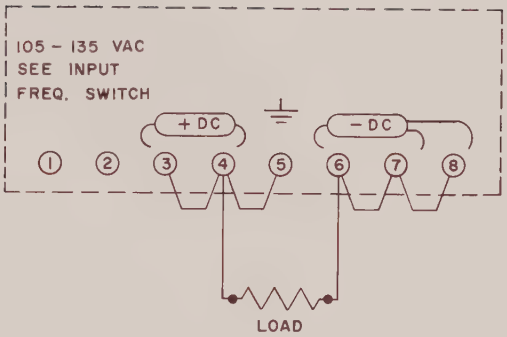


FIG. 3. CABLE LENGTH "A" IN FEET



(a)

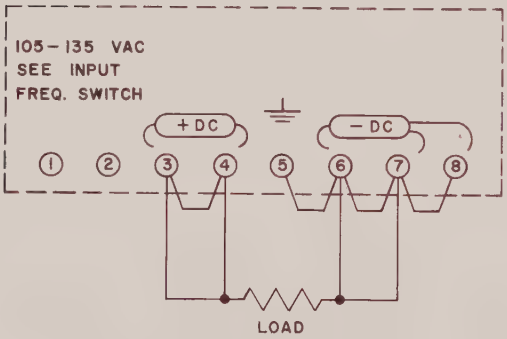
NEGATIVE TERMINAL GROUNDED



(b)

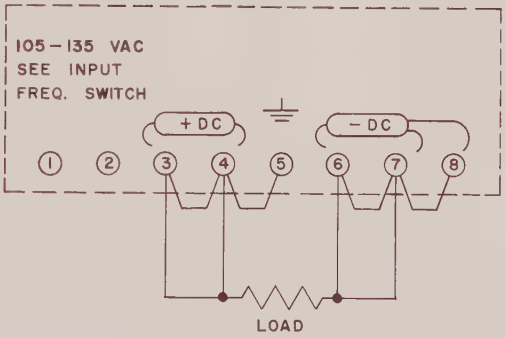
POSITIVE TERMINAL GROUNDED

FIG. 4. TWO – WIRE CONNECTION



(a)

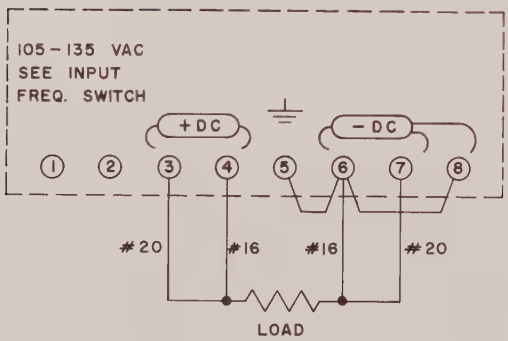
NEGATIVE TERMINAL GROUNDED



(b)

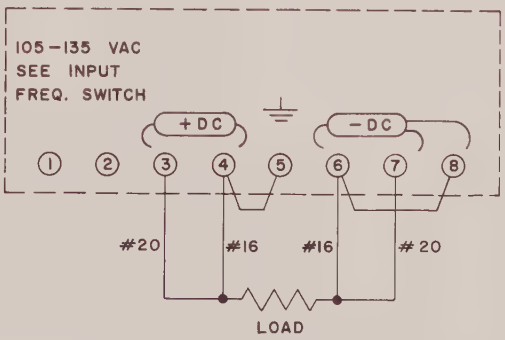
POSITIVE TERMINAL GROUNDED

FIG. 5. IMPROVED TWO – WIRE CONNECTION



(a)

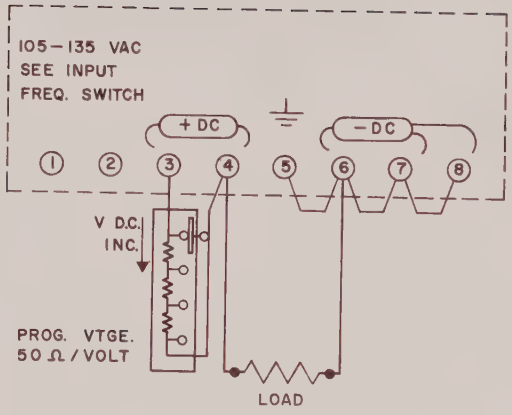
NEGATIVE TERMINAL GROUNDED



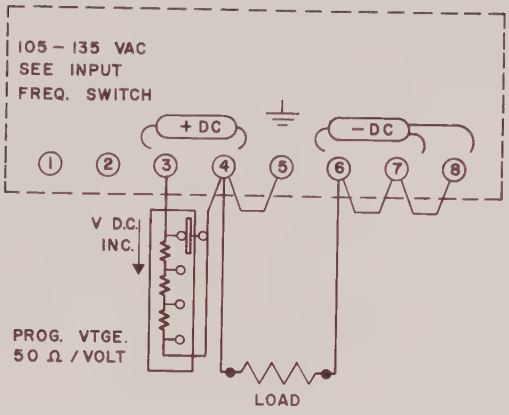
(b)

POSITIVE TERMINAL GROUNDED

FIG. 6. FOUR – WIRE CONNECTION

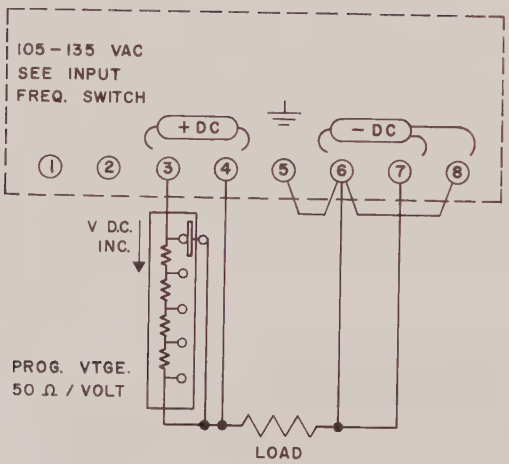


(a)
NEGATIVE TERMINAL GROUNDED

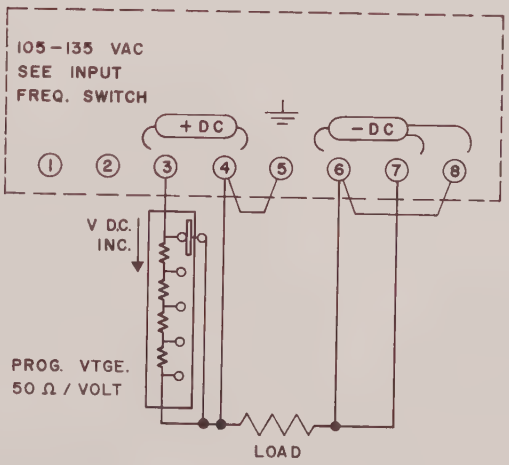


(b)
POSITIVE TERMINAL GROUNDED

FIG. 7. PROGRAMMED VOLTAGE, LOCAL SENSING

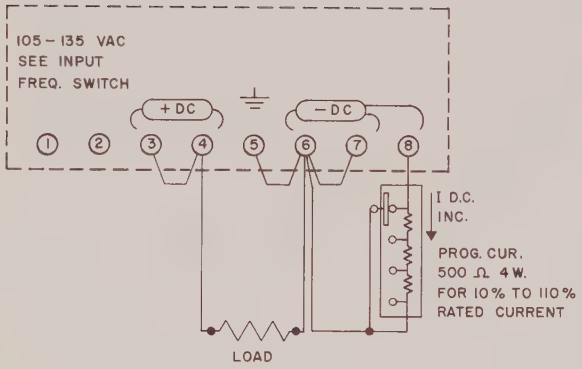


(a)
NEGATIVE TERMINAL GROUNDED

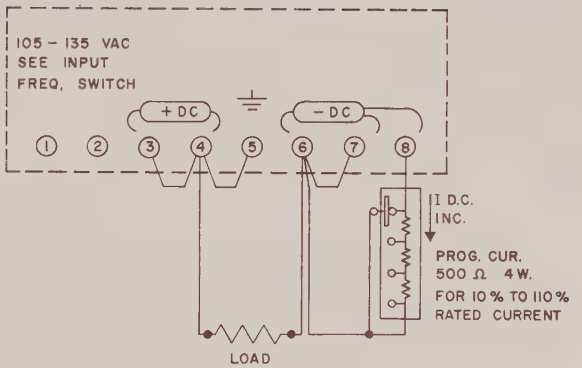


(b)
POSITIVE TERMINAL GROUNDED

FIG. 8. PROGRAMMED VOLTAGE, REMOTE SENSING

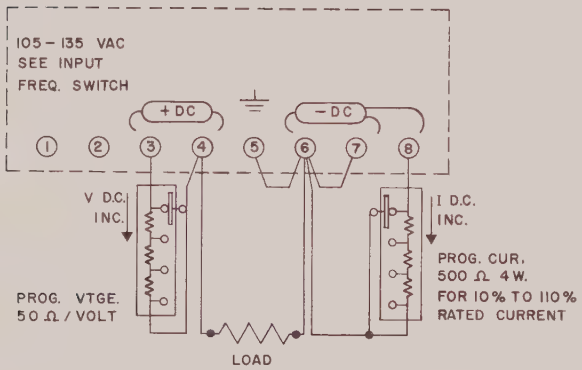


(a)
NEGATIVE TERMINAL GROUNDED

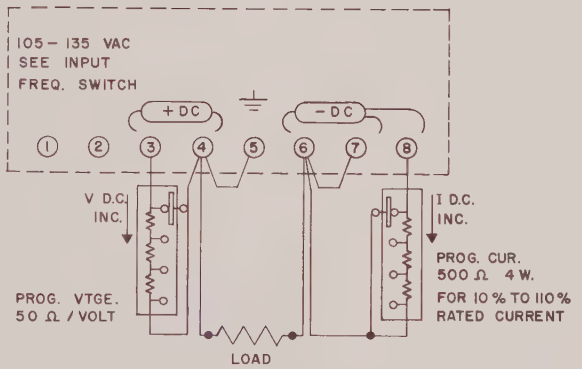


(b)
POSITIVE TERMINAL GROUNDED

FIG. 9. PROGRAMMED CURRENT

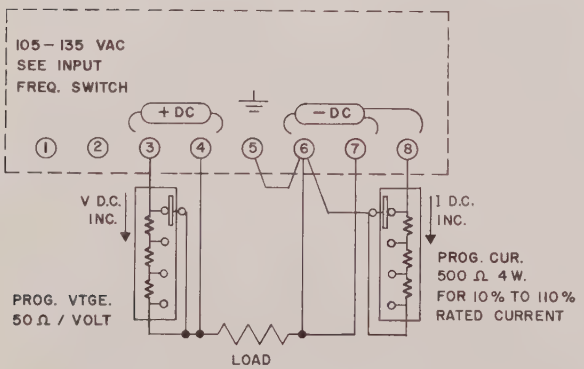


(a)
NEGATIVE TERMINAL GROUNDED

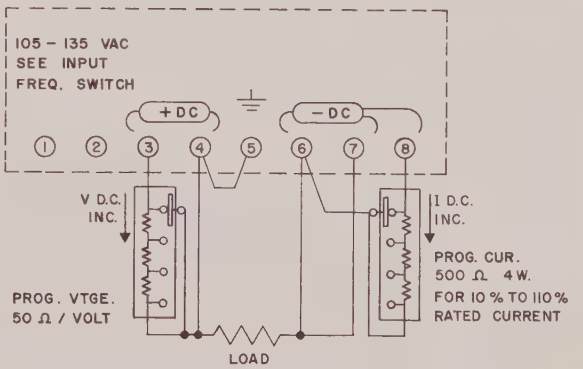


(b)
POSITIVE TERMINAL GROUNDED

FIG. 10. PROGRAMMED VOLTAGE, LOCAL SENSING & PROGRAMMED CURRENT

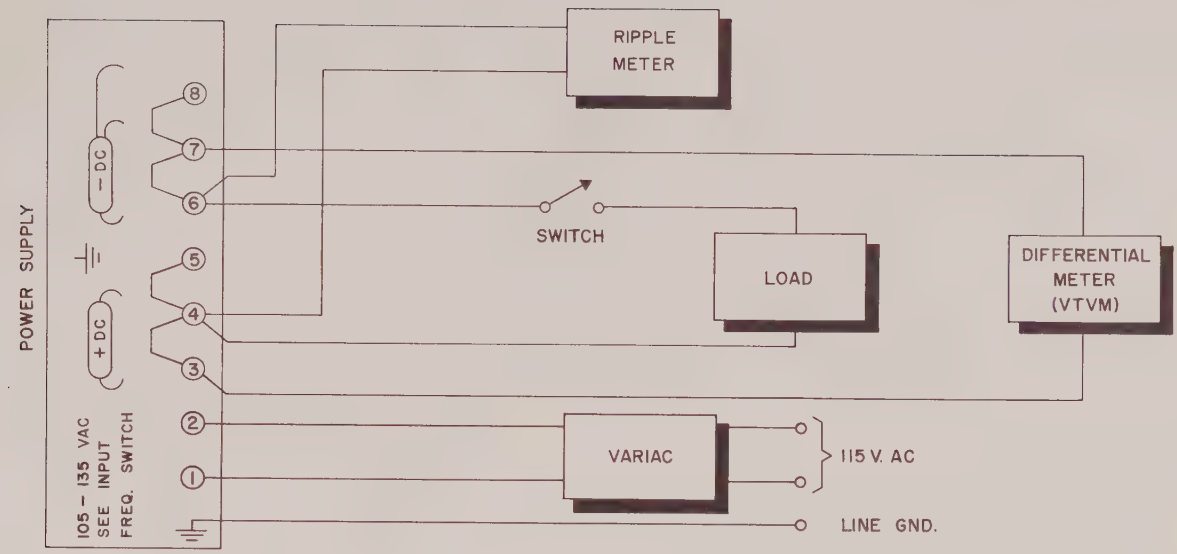


(a)
NEGATIVE TERMINAL GROUNDED



(b)
POSITIVE TERMINAL GROUNDED

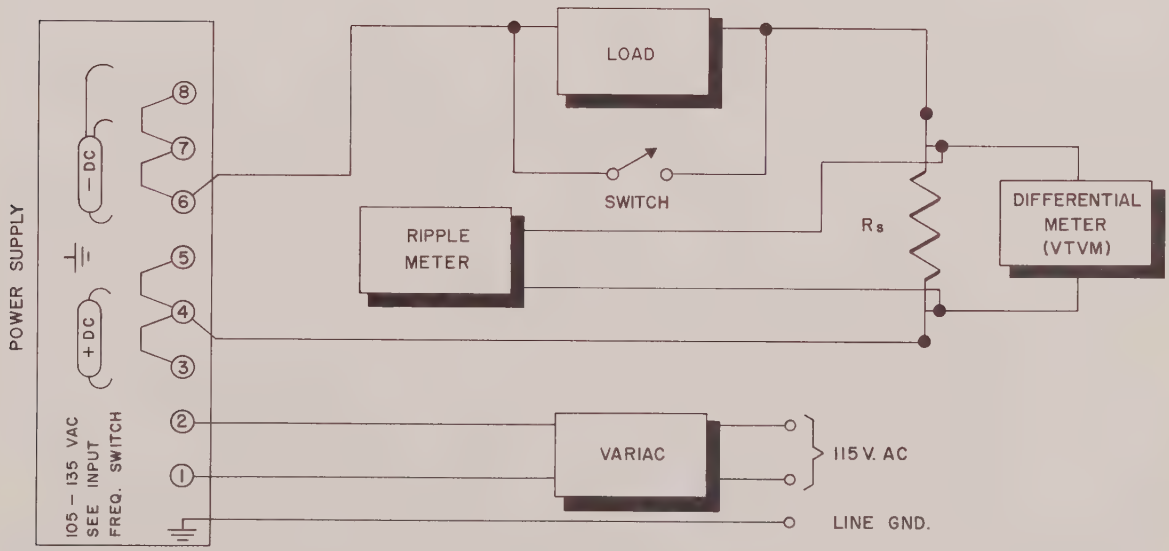
FIG. 11. PROGRAMMED VOLTAGE, REMOTE SENSING & PROGRAMMED CURRENT



NOTES:

1. REGULATION AND RIPPLE CHECK METERS MUST NOT BE GROUNDED THROUGH THREE-WIRE LINE CORD TO GROUND.
2. PERFORM CHECKS WITH LOCAL SENSING CONNECTIONS ONLY.

FIG. 12. TEST CONNECTIONS FOR CONSTANT VOLTAGE PERFORMANCE CHECKS



NOTES:

1. REGULATION AND RIPPLE CHECK METERS MUST NOT BE GROUNDED THROUGH THREE-WIRE LINE CORD TO GROUND.
2. PERFORM CHECKS WITH LOCAL SENSING CONNECTIONS ONLY.

FIG. 13. TEST CONNECTIONS FOR CONSTANT CURRENT PERFORMANCE CHECKS

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ELECTRICAL PARTS LIST, MODEL LE 101, LE 101-M, LE 101-[illegible]

CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
C1		Capacitor, fixed, electrolytic, 4 mfd -10% +100%, 80 vdcw	CBN-40-004	F	NLH334P		
C2		Capacitor, fixed, tantalum, 0.22 mfd ±20%, 35 vdcw	CBM-22-001	AU	150D224-X0035A2		
C3		Capacitor, fixed, paper, 0.01 mfd ±10%, 100 vdcw	CAL-10-007	AU	191P1039-1S4		
C4		Not assigned					
C5		Capacitor, fixed, paper, 0.015 mfd ±10%, 100 vdcw	CAL-15-008	AU	191P1539-1S4		
C6		Capacitor, fixed, paper, 0.0047 mfd ±10%, 100 vdcw	CAK-47-001	AU	191P4729-1S4		
C7	*	Capacitor, fixed, electrolytic, 1000 mfd -10% +100%, 25 vdcw	CBS-10-012				
C8	*	Capacitor, fixed, electrolytic, 10 mfd -10% +100%, 150 vdcw	CBP-10-005				
C9	*	Capacitor, fixed, paper, 4 mfd ±10%, 200 vdcw	CAN-40-022				
C10	*	Capacitor, fixed, electrolytic, 165 mfd -0% +150%, 60 vdcw, 90v surge	CBR-16-013				
C11		Capacitor, fixed, electrolytic, 8 mfd -0%, +40%, 50 vdcw	CBN-80-005	F	NLH8-50P		
C12	*	Capacitor, fixed, electrolytic, 150 mfd -10% +100%, 50 vdcw	CBR-15-007				

CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
C13		Capacitor, fixed, tantalum, 0.82 mfd ±10%, 35 vdcw	CBM-82-002	AU	150D824X-9035A2		
C14	*	Capacitor, fixed, electrolytic, 100 mfd -0% +40%, 35 vdcw	CBR-10-017				
C15		Capacitor, fixed, electrolytic, 10 mfd -10% +100%, 50 vdcw	CBP-10-007	F	NLH10-50P		
C16		Capacitor, fixed, tantalum, 2.2 mfd ±20%, 50 vdcw	CBN-22-007	AU	150D225X-0050B2		
C17		Capacitor, fixed, tantalum, 1.0 mfd ±10%, 20 vdcw	CBN-10-003	AU	150D105X-9020A2		
C18		Capacitor, fixed, tantalum, 0.068 mfd ±20%, 75 vdcw	CBL-68-002	AU	150D683X-0075A2		
C19		Same as C12					
C20		Same as C10					
C21	*	Capacitor, fixed, electrolytic, 1200 mfd -10% +100%, 60 vdcw, 90v surge	CBS-12-011				
C22		Not assigned					
C23	*	Capacitor, fixed, electrolytic, 9000 mfd -10% +100%, 60 vdcw, 90v surge	CBS-90-010				
C24		Same as C23					
C25 thru C27		Not assigned					

CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
C29		Capacitor, fixed, paper, 0.001 mfd ±20%, 200 vdcw	CAK-10-002	AU	191P1020-2S4		
C30	++	Capacitor, fixed, paper, 0.01 mfd ±20%, 200 vdcw	CAL-10-009	AU	196P1030-2S4		
C31	+	Same as C29					
C32	+	Capacitor, fixed, paper 0.0047 mfd ±10%, 300vdcw	CAK-47-003	AU	196P4729-3S4		
C33	++	Same as C2					
C34-41		Not assigned					
C42	##	Capacitor, fixed, mica, 470 mmfd, ±20%, 300 vdcw	CCJ-47-004	F	22R3T47		
C43		Not assigned					
C44	##	Same as C42					
CR1 thru CR3		Rectifier, semi-conductor, silicon, (1N 645 family)	FBL-00-030	N	4JA6WX31		
CR4	*	Rectifier, semi-conductor, zener diode	FBM-E564				
CR5		Rectifier, semi-conductor, germanium	FBL-00-031	Y	1N2326		
CR6		Same as CR4					
CR7		Same as CR1					
CR8		Same as CR1					
CR9		Not assigned					
CR10		Rectifier, semi-conductor, zener diode	FBM-10M50Z10	AV	10M50Z10		
CR11		Rectifier, semi-conductor, zener diode	FBM-SZ-560	AV	1N936		

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ELECTRICAL PARTS LIST, MODEL LE 101, LE 101-M, LE 101-FM

CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
CR12 thru CR17		Same as CR1					
CR18		Rectifier, semi-conductor, silicon	FBL-00-033	N	1N646		
CR19		Rectifier, semi-conductor, silicon	FBL-00-029	N	4JA36UX118		
CR20 thru CR23		Rectifier, semi-conductor, silicon, stud mounting	FBL-00-022				
CR24		Rectifier, semi-conductor, silicon	FBL-00-034	N	1N2610		
CR25		Same as CR1					
CR26		Same as CR1					
CR27		Same as CR4					
CR28 thru CR36		Same as CR1; CR33 & CR35 are matched pair Lambda no. FBL-00-030MP					
CR37		Not assigned					
CR38 thru CR41		Same as CR1					
CR42		Not assigned					
CR43		Same as CR19					

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CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
CR44		Not assigned					
CR45		Not assigned					
CR46		Same as CR19					
CR47		Same as CR19					
CR48		Rectifier, semi-conductor, germanium	FBL-00-032	N	1N91		
CR49		Rectifier, semi-conductor, silicon, 1N538 type	FBL-00-027	N	4JA4BX460		
F1		Fuse, cartridge, 1.250 amp, 3AG, Slo-Blo	FFC-01-250	E	MDL1.250		
F2		Fuse, cartridge, 15 amp, 3AG, Slo-Blo	FFC-15-000	E	MDL15		
I1		**Pilot Lamp assembly with lamp cartridge**	HRD-00-006				
I2		Pilot lamp assembly	HRD-00-005	AF	26408H-991		
		Lamp, neon, bayonet base		N	NE51H		
I3		Pilot lamp assembly	HRD-00-004	AF	26410-992		
		Lamp, incandescent		N	47		
M1	* °	Meter, Volts DC, 0-1 ma movement, full scale reading 0-36 vdc	EBP-36-009				
M2	* °	Meter, Amperes DC, full scale reading 0-5 amperes	EDN-50-010				
Q1	*	Transistor, semi-conductor, germanium, PNP, type 2N404, 1st DC amplifier	FBN-CP-2293				
Q2		Same as Q1, 2nd DC amplifier					

CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
Q3	*	Transistor, semi-conductor, germanium, NPN, type 2N388, differential input amplifier	FBN-CP-2388				
Q4		Same as Q3, differential input amplifier					
Q5		Same as Q1, DC amplifier					
Q6		Same as Q1, 1st emitter follower					
Q7	*	Transistor, semi-conductor, silicon, NPN, type 2N697, 2nd emitter follower	FBN-CP-2357				
Q8		Same as Q3, current regulator					
Q9	*	Transistor, semi-conductor, silicon, NPN, type 2N2270, controlled switch	FBN-CP-34634				
Q10	*	Transistor, semi-conductor, germanium, PNP, type 2N1183	FBN-2N1183				
Q11		Same as Q3, emitter follower					
Q12	*	Transistor, semi-conductor, germanium, PNP, type 2N1542, emitter follower/regulator	FBN-SP-787				
Q13	*	Transistor, semi-conductor, germanium, PNP, type 2N1183, input amplifier	FBN-CP34759				
Q14		Same as Q7, gate switch					
Q15		Same as Q3, voltage reset					
Q16		Same as Q1, voltage comparator					

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ELECTRICAL PARTS LIST, MODEL LE 101, LE 101-M, LE 101-FM

CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
Q17		Same as Q7, gate switch					
Q18		Same as Q12, constant current internal load					
Q19	*	Transistor, semi-conductor, germanium, PNP, type 2N2079, regulator	FBN-SP-736				
Q20		Same as Q19					
R1	*	Resistor, variable, wirewound, 50 ohms ±5%, 4W	DNP-50-001				
R2	*	Resistor, variable, wirewound, 1750 ohms ±5%, 4W	DNS-17-008				
R3	*	Resistor, fixed, wirewound, multitap, 260 ohms total resistance ±5%, 15W	DFR-26-043				
R4	*	Resistor, variable, wirewound, 100 ohms ±5%, 4W	DNR-10-005				
R5		Resistor, fixed, composition, 27,000 ohms ±10%, 1/2W	DEB-2731	A	EB2731		
R6	*	Resistor, fixed, wirewound, 100 ohms ±5%, 2W	DFR-10-035				
R7		Resistor, fixed, composition, 2,200 ohms ±10% 1/2W	DEB-2221	A	EB2221		
R8		Not assigned					
R9		Same as R7					
R10		Resistor, fixed, composition, 1,200 ohms ±10%, 1/2W	DEB-1221	A	EB1221		

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ELECTRICAL PARTS LIST, MODEL LE 101, LE 101-M, LE 101-FM

CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
R11	*	Resistor, fixed, wirewound, 300 ohms ±5%, 2W	DFR-30-040				
R12		Resistor, fixed, composition, 4,700 ohms ±10%, 1/2W	DEB-4721	A	EB4721		
R13	*	Resistor, fixed, wirewound, 50 ohms ±5%, 2W	DFP-50-017				
R14	*	Resistor, variable, wirewound, 500 ohms ±5%, 4W	DNR-50-006				
R15	*	Resistor, fixed, wirewound, 4,000 ohms ±2%, 3W	DFS-40-017				
R16	*	Same as R1					
R17	!	**Resistor,fixed, composition, 220ohms ±10%,1/2W**	**DEB 2211**	**A**	**EB 2211**		
R17		Resistor, fixed, composition, 820 ohms ±10%, 1/2W	DEB-8211	A	EB8211		
R18		Resistor, fixed, composition, 680 ohms, ±10%, 1/2W	DEB-6811	A	EB6811		
R19		Same as R12					
R20		Resistor, fixed, composition, 220,000 ohms ±10%, 1/2W	DEB-2241	A	EB2241		
R21		Same as R17					
R22	*	Resistor, fixed, wirewound, 100 ohms ±5%, 5W	DFR-10-025				
R23	*	Resistor, fixed, wirewound, 25 ohms ±5%, 3W	DFP-25-023				
R23	#*	**Resistor,fixed, wirewound 50ohms ±5%, 5W**	**DFP-50-020**				
R24	*	Resistor, fixed, wirewound, 50 ohms ±5%, 4W	DFP-50-021				
R25		Resistor, fixed, wirewound, 390 ohms ±5%, 2W	DFR-39-026	R	BWH390		

CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
R26		Resistor, fixed, metallic film, 82 ohms ±1%, 1/4W	DCP-82-001	AB	WL65-T0 82 ohms		
R27		Resistor, fixed, composition, 3,300 ohms ±10%, 1/2W	DEB-3321	A	EB3321		
R28		Resistor, fixed, composition, 12,000 ohms ±10%, 1/2W	DEB-1231	A	EB1231		
R29		Resistor, fixed, composition, 18 ohms ±10%, 1W	DGB-1801	A	GB1801		
R30		Resistor, fixed, composition, 100,000 ohms ±10%, 1/2W	DEB-1041	A	EB1041		
R31	*	Resistor, fixed, wirewound, 2,000 ohms ±5%, 2W	DFS-20-027				
R32		Same as R30					
R33		Same as R30					
R34		Resistor, fixed, composition, 1,800 ohms ±5%, 2W	DHB-1825	A	HB1825		
R35		Not assigned					
R36	*	Resistor, fixed, wirewound, 5 ohms ±5%, 10W	DFN-50-034				
R37		Resistor, fixed, composition, 22,000 ohms ±10%, 1/2W	DEB-2231	A	EB2231		
R38	*	Resistor, fixed, wirewound, 20 ohms ±5%, 15W	DFP-20-018				
R39	*	Resistor, fixed, wirewound, 800 ohms ±5%, 2W	DFR-80-037				

CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
R40		Resistor, fixed, composition, 10,000 ohms ±5%, 1/2W	DEB-1035	A	EB1035		
R41		Resistor, fixed, composition, 39 ohms ±5%, 1/2W	DEB-3905	A	EB3905		
R42		Same as R41					
R43		Resistor, fixed, composition, 10 ohms ±10%, 1/2W	DEB-1001	A	EB1001		
R44		Resistor, fixed, composition, 240 ohms ±5%, 1/2W	DEB-2415	A	EB2415		
R45	*	Resistor, fixed, wirewound, 65 ohms ±5%, 2W	DFP-65-022				
R46	*	Resistor, fixed, wirewound, 200 ohms ±5%, 2W	DFR-20-036				
R47	*	Resistor, fixed, wirewound, 1,000 ohms ±5%, 2W	DFS-10-029				
R48		Same as R39					
R49	*	Resistor, variable, wirewound, 5,000 ohms ±5%, 4W	DNS-50-009				
R50	+	**Resistor, fixed, composition, 100 ohms ±10%, 1/2W**	**DEB 1011**	**A**	**EB 1011**		
R50		Resistor, fixed, composition, 1,000 ohms ±10%, 1/2W	DEB-1021	A	EB1021		
R51		Same as R31					
R52		Same as R47					

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CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
R53		Resistor, fixed, composition, 200 ohms ±5%, 1/2W	DEB-2015	A	EB2015		
R54	*	Resistor, fixed, wirewound, 600 ohms ±5%, 2W	DFR-60-045				
R55	*	Resistor, fixed, wirewound, multitap, total resistance 60 ohms ±5%, 10W	DFP-60-019				
R56		Resistor, fixed, composition, 22 ohms ±10%, 1/2W	DEB-2201	A	EB2201		
R57		Same as R50					
R58		Resistor, fixed, composition, 18 ohms ±10%, 1/2W	DEB-1801	A	EB1801		
R59		Resistor, fixed, composition, 10,000 ohms ±10%, 1/2W	DEB-1031	A	EB1031		
R60		Same as R59					
R61		Resistor, fixed, composition, 47 ohms ±10%, 1/2W	DEB-4701	A	EB4701		
R62		Resistor, fixed, metallic film, 23,000 ohms ±1%, 1/2W	DCT-23-004	AB	WL70-TO 23K		
R63	*	Resistor, fixed, wirewound, 2,000 ohms ±5%, 3W	DFS-20-032				
R64	*	Resistor, fixed, wirewound, 0.3 ohm ±5%, 32W	DFM-30-017				
R65	*	Resistor, fixed, wirewound, 475 ohms ±5%, 20W	DFR- 47-028				
R66	*	Resistor, fixed, wirewound, 4 ohms ±5%, 3W	DFN-40-043				

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CIRCUIT REF.	NOTES	DESCRIPTION OF PART	LAMBDA PART NO.	MFR. (SEE CODE)	MFRS. DESIGNATION	SPARE PARTS 1 YEAR	
R67	*	Resistor, fixed, wirewound, 0.19 ohm ±5%, 16W	DFM-19-022				
R68	*	Resistor, fixed, wirewound, 5 ohms ±2%, 5W	DFN-50-033				
R69	*	Resistor, fixed, wirewound, 0.5 ohm ±2%, 5W	DFM-50-015				
R70		Same as R69					
R71 thru R78		Not assigned					
R79		Same as R43					
R80	+	Resistor, fixed, composition, 10 ohms ±10%, 1/2W	DEB-1001	A	EB1001		
R81	++	Same as R43					
S1		Switch, toggle, SPDT	FDA-12-015	J	8816K9		
S2		Switch, toggle, SPST	FDA-11-014	J	8803K10		
S3		Switch, toggle, DPST	FDA-21-013	J	8823K6		
SCR1	*	Rectifier, controlled, silicon	FBP-00-001				
T1, T3, L1	*	Transformer and choke (L1), hermetically sealed unit containing T1, T3 and L1	ABA-101				